020160

JPRS-JST-86-037

4 DECEMBER 1986

Japan Report

SCIENCE AND TECHNOLOGY

FBIS FOREIGN BROADCAST INFORMATION SERVICE

REPRODUCED BY
U.S. DEPARTMENT OF COMMERCE
NATIONAL TECHNICAL
INFORMATION SERVICE
SPRINGFIELD, VA. 22161

17
45
A05

NOTE

JPRS publications contain information primarily from foreign newspapers, periodicals and books, but also from news agency transmissions and broadcasts. Materials from foreign-language sources are translated; those from English-language sources are transcribed or reprinted, with the original phrasing and other characteristics retained.

Headlines, editorial reports, and material enclosed in brackets [] are supplied by JPRS. Processing indicators such as [Text] or [Excerpt] in the first line of each item, or following the last line of a brief, indicate how the original information was processed. Where no processing indicator is given, the information was summarized or extracted.

Unfamiliar names rendered phonetically or transliterated are enclosed in parentheses. Words or names preceded by a question mark and enclosed in parentheses were not clear in the original but have been supplied as appropriate in context. Other unattributed parenthetical notes within the body of an item originate with the source. Times within items are as given by source.

The contents of this publication in no way represent the policies, views or attitudes of the U.S. Government.

PROCUREMENT OF PUBLICATIONS

JPRS publications may be ordered from the National Technical Information Service, Springfield, Virginia 22161. In ordering, it is recommended that the JPRS number, title, date and author, if applicable, of publication be cited.

Current JPRS publications are announced in Government Reports Announcements issued semi-monthly by the National Technical Information Service, and are listed in the Monthly Catalog of U.S. Government Publications issued by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

Correspondence pertaining to matters other than procurement may be addressed to Joint Publications Research Service, 1000 North Glebe Road, Arlington, Virginia 22201.

JPRS-JST-86-037
4 DECEMBER 1986

JAPAN REPORT

SCIENCE AND TECHNOLOGY

CONTENTS

/9987

ENERGY

102D POWER DEVELOPMENT REGULATORY COUNCIL CONFERENCE

Tokyo DENKI TO GASU in Japanese May 86 pp 11-14

[Article by Terukazi Iwamoto, power development official, General Planning Bureau, Economic Planning Agency]

[Text] The 102d Power Development Regulatory Council was held on 20 March 1986. The following plans were adopted based on the 100th council (17 July 1985) and the 101st council (29 November 1985), which were conferences for the FY 1985 Power Development Basic Project:

1. Accomplishment of an approximately 66.2-million kw power supply within the next 10 years from 1985 as a long-term power development objective.

2. In addition, as the power development plan for FY 1985, new construction of power plants with a total capacity of about 100,000 kw of the approximately 615-million kw power supply planned for FY 1985, and ¥3.4473 trillion in funds for power plant development, including power transmission and distribution stations, etc.

Added to the power development plan for FY 1985 was the construction of six new hydroelectric power stations with a total capacity of about 40,000 kw of power supply which resulted in approximately ¥200 million in additional funds (anticipated expenditures for FY 1985).

Moreover, the target for new power source capacity was set at about 1.3 million kw scheduled to be referred to the current fiscal year power development council (proposed new construction scale). However, this new addition of about 40,000 kw as new power sources increased total capacity to about 1.4 million kw.

Outline of New Power Stations

Construction is to begin at the following six hydroelectric power sites:

1. Osasasho (Tohoku Electric Power Corp.)

This power station is a water-channel power plant located in Fukushima City, Fukushima Prefecture to be constructed across the Matsu tributary of the Abukuma River waterway. Its maximum output is 11,400 kw with a total

construction cost of ¥8.012 billion at ¥703,000 per kw. The scheduled beginning of operation is December 1990 with completion estimated in April 1991.

2. Naramata (Gunma Prefecture)

This power station is a dam-type power plant located in Mizukami Town, Tone County, Gunma Prefecture to be constructed across the Yumata tributary of the Tone River waterway. Its maximum output is 12,400 kw and its construction cost is ¥3.9 billion with the unit cost of construction placed at ¥319,000 per kw. Operation is scheduled to begin in December 1989 with completion in November 1989.

3. Arakobuchi (Ishikawa Prefecture)

This power station is a dam-type power plant located in Yamanaka Town, Enuma Co., Ishikawa Prefecture constructed across the Daiseiji River of the Daiseiji River waterway. Maximum output is 3,600 kw and the total construction cost is ¥3.179 billion with a unit construction cost of ¥883,000 per kw. Operation is scheduled for March 1994 with an estimated completion date also of March 1994.

4. Shinbago (Tottori Prefecture)

This power station is a water-channel power plant located in Kishimoto Town, Seihaku County, Tottori Prefecture to be constructed across the Hino River of the Hino River waterway. Maximum output is 9,200 kw and total construction cost is ¥9.6 billion with a unit construction cost of ¥9.6 million per kw. It is scheduled for operation in July 1988 and the estimated completion date is June 1988.

5. Hanagono River (Oita Prefecture)

This power station is a water-channel power plant located in Yufuin Town, Oita County, Oita Prefecture to be constructed across the Hangono River of the Oita River waterway. Maximum output is 680 kw and total construction cost amounts to ¥7.2 million with a unit construction cost of ¥1.059 million per kw. It is scheduled for operation in November 1988 and completion is estimated to be in October 1988.

6. Toyoura (Hokkaido Hydroelectric Power Corp.)

This power station is a water-channel power plant located in Toyoura Town, Abuta County, Hokkaido to be constructed across the Kankibetsu River and the Shinyamanashi River of the Kankibetsu River waterway. Maximum output is 3,400 kw and total construction cost amounts to ¥43 million with a unit construction cost of ¥1.265 million per kw. It is scheduled for operation in April 1989 with estimated completion in June 1989.

Table 1. Maximum Output of Power Plant Facilities According to Power Source and Funds Required for Development (amended FY 1985 Power Source Development Plan)

Enterprise category	Classified by power source	New or continuing category	Maximum output of power plant facilities (million kw)	Total construction funds (¥100 million)	Estimated expenditures for FY 1985 (¥100 million)
Nine electric power companies	Hydraulic	New	7	462	5
		Continuing	754	16,336	1,564
		Total	761	16,798	1,569
	Thermal	New	2	52	0
		Continuing	2,777	61,239	5,280
		Total	2,779	61,291	5,280
	Nuclear	New	--	--	--
		Continuing	1,897	64,337	5,581
		Total	1,897	64,337	5,581
	Subtotal	New	9	514	5
		Continuing	5,428	141,913	12,425
		Total	5,437	142,427	12,430
Power Source Development Corp.	Hydraulic	New	--	--	--
		Continuing	150	3,422	239
		Total	150	3,422	239
	Thermal	New	--	--	--
		Continuing	231	4,984	635
		Total	231	4,984	635
	Subtotal	New	--	--	--
		Continuing	381	8,406	873
		Total	381	8,406	873
Public Corporate Operation	Hydraulic	New	4	384	6
		Continuing	15	1,111	169
		Total	19	1,495	175
Other electric enterprises, etc.	Hydraulic	New	1	77	1
		Continuing	1	131	41
		Total	2	209	42
	Thermal	New	--	--	--
		Continuing	200	6,005	104
		Total	200	6,005	104
	Nuclear	New	--	--	--
		Continuing	116	4,204	869
		Total	116	4,204	869
	Subtotal	New	1	77	1
		Continuing	317	10,341	1,013
		Total	318	10,418	1,014
Grand total	Hydraulic	New	12	923	12
		Continuing	919	21,001	2,013
		Total	931	21,924	2,024

[continued]

[Continuation of Table 1]

Enterprise category	Classified by power source	New or continuing category	Maximum output of power plant facilities (million kw)	Total construction funds (¥100 million)	Estimated expenditures for FY 1985 (¥100 million)
	Thermal	New	2	52	0
		Continuing	3,209	72,228	6,018
		Total	3,211	72,280	6,018
	Nuclear	New	—	—	—
		Continuing	2,013	68,541	6,450
		Total	2,013	68,541	6,450
	Subtotal	New	14	975	12
		Continuing	6,141	161,771	14,480
		Total	6,155	162,746	14,492

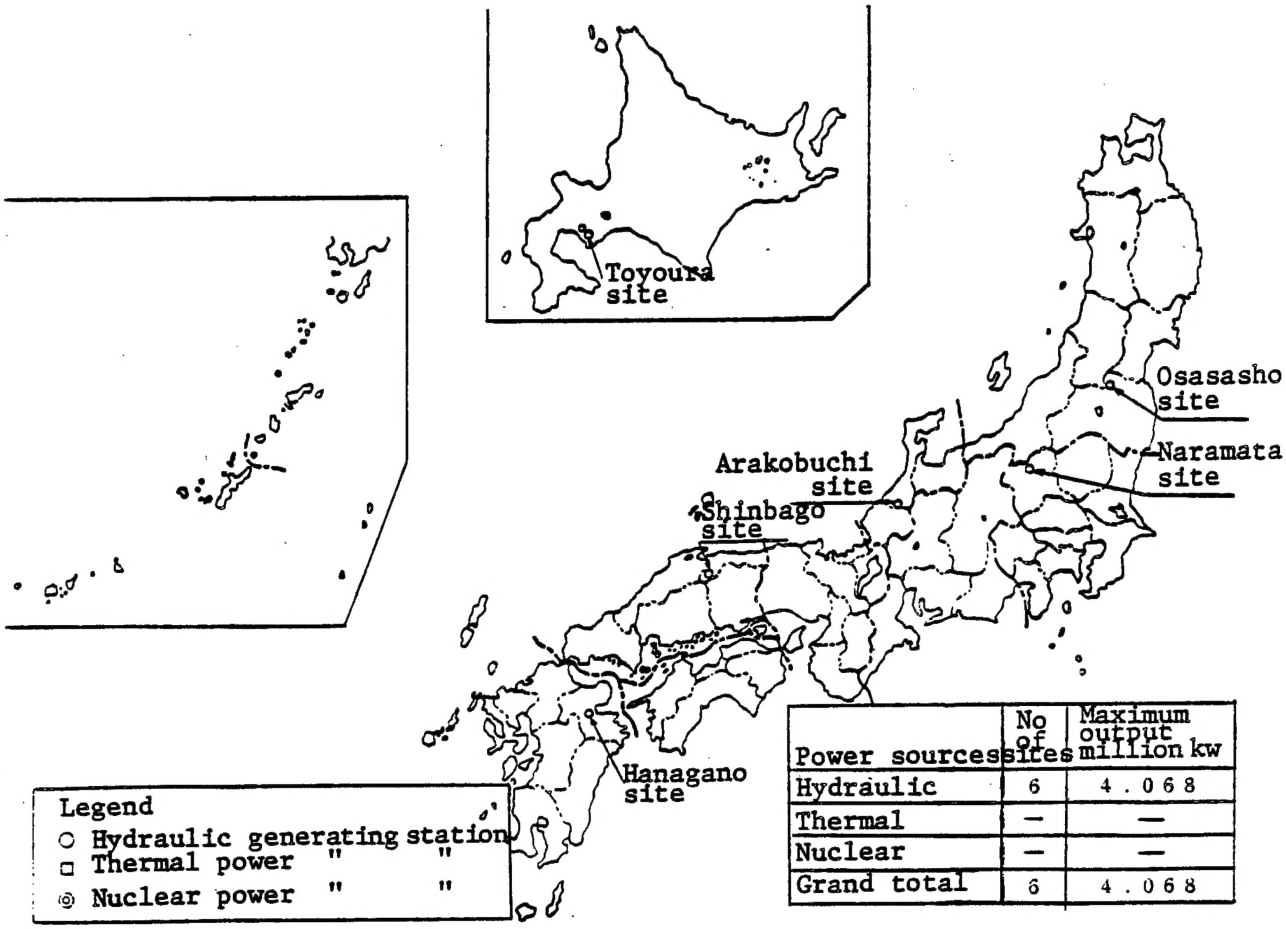
Note: Fractions have been rounded off.

Table 2. Funds Required for Construction Area (estimated expenditures for FY 1985)

Enterprise category	New or continuing category	Power generation area	Area of power trans-mission distri-bution, etc.	Modifi-cation work, etc.	Total
Nine electric power companies	New	3	4,758	7,612	12,375
	Continuing	12,425	3,313	3,078	18,815
	Total	12,430	8,071	10,690	31,191
Power Source Development Corp.	New	—	83	332	415
	Continuing	873	62	—	935
	Total	873	145	332	1,351
Public corporate operation	New	6	—	56	62
	Continuing	169	—	—	169
	Total	175	—	56	231
Other electric enterprises, etc.	New	1	48	424	473
	Continuing	1,013	12	205	1,230
	Total	1,014	61	628	1,703
Grand total	New	12	4,889	8,424	13,325
	Continuing	14,480	3,387	3,282	21,150
	Total	14,492	8,276	11,706	34,475

Table 3. New Power Source Developmental Sites

Names of enterprises	Names of power generating stations	Locations of power stations	Rivers utilized: Main rivers	Rivers utilized: Tributaries	Types of systems	Maximum output (kw)	Scheduled starting date of construction	Estimated date of completion
Tohoku Electric Power Corp.	Osasasho	Fukushima City, Fukushima Prefecture	Abukuma	Matsu	Water channel	11,400	March 1986	April 1991
Guna Prefecture	Naramata	Mizukami Town, Tone County, Gunma Prefecture	Tone	Naramata	Dam	12,400	March 1986	November 1989
Ishikawa Prefecture	Arakobuchi	Yamanaka Town, Enuma County, Ishikawa Prefecture	Daiseiji River		Dam	3,600	March 1986	March 1994
Tottori Prefecture	Shinbago	Kishimoto Town, Seihaku County, Tottori Prefecture	Hino River		Water channel	9,200	March 1986	June 1988
Oita Prefecture	Hanagono	Yufuin Town Oita County Oita Prefecture	Oita	Hanagono	Water channel	680	March 1986	October 1988
Hokkaido Hydroelectric Power Corp.	Toyoura	Toyoura Town, Abuta County Hokkaido	Kankibetsu	Kankibetsu Shinyama-nashi	Water channel	3,400	June 1986	June 1989



Power sources	No of sites	Maximum output million kw
Hydraulic	6	4.068
Thermal	—	—
Nuclear	—	—
Grand total	6	4.068

Figure 1. Location of Additional Sites Set for Construction

20,130/9365
CSO: 4306/2609

ACTIVITIES OF POLYMERIC MATERIALS CENTER DISCUSSED

Tokyo KOGYO ZAIRYO in Japanese Sep 86 pp 1-12

[Text] The purpose of the change from the "Japan Plastic Inspection Association" to the "Polymeric Materials Center" is to cope with a new era.

Interviewer Mr Suzuki: Please tell readers of KOGYO ZAIRYO magazine about the activities of the Polymeric Materials Center (Foundation) and also some stories relating to polymeric materials you have obtained on your many trips overseas.

Interviewee Mr Hayashi: Let's take an overview of the Polymeric Materials Center first. The Polymeric Materials Center was founded on 1 October 1985, with strong support from the Chemical Product Section of the Basic Industry Bureau of MITI. The center continues to perform tests and inspections which the Japan Plastic Inspection Association has performed, plus tests and inspections of additional new materials. The objective of the Polymeric Materials Center is to contribute to the new-material industry and to bring national benefits.

Originally the Japan Plastic Inspection Association had been performing tests and inspections of plastics and certifications and hygienic tests of food. During that period, the necessity for standardized evaluation of new materials occurred.

Requests for an organization, similar to ISO (International Standardization Organization) relating to plastics, have been strong in Japan for over 10 years. ISO specifications are similar to Japan's JIS. I have been involved in establishing a standard testing method which is a basis for tests and inspections. This organization is called the "Plastic Standard Testing Method Study Group." This is a private organization and has about a 30-year history. I was asked to take over the job.

The Inspection Association, as I mentioned before, has been heavily involved in standardization and has made international contributions. There was a movement to create a center which engages in evaluation standardization, the research and development of new materials, information collection, data base creation, etc. Then the organization, the Plastic Evaluation Technology Study Group, was created within the Plastic Inspection Association a few years ago.

Just about the same time, when we were obtaining a consensus about the needs of the study group, there was a mood in MITI to promote a new project regarding new materials.

Around that time, 12 projects, with a duration of 8-10 years, simultaneously started in 1981 regarding the next generation's key industrial technology research and development in the Technology Academy of MITI. Composite material was one of the 12 projects. To be precise, the "Next-Generation Metal and Composite Material Research and Development Association" was established. Our Polymeric Materials Center assists the association.

High Goal Under a New Star "Polymeric Materials Center"

Hayashi: You may ask what the Polymeric Materials Center's goal is. I will explain in a simple way so that the general public can understand. When looking at the life of a material, first a new material is born, produced in a plant, processed into a product, used as a product, or sometimes reused, then its life ends. I think it is very important to look at the creation of new materials, from the viewpoint of the material system, by looking from what has to be done to produce a new material and what are the users' needs and manufacturers' perceptions. In particular, I myself have a strong tendency to a material system since I researched theoretical and application studies at Tokyo University as a user but not as a manufacturer.

So far, manufacturers were more advanced in the material field. For users, it seems that the language (interviewer's note: this means terminology or concept) used by users and manufacturers is different. Thus, users and manufacturers cannot communicate well. This, I think, is a major barrier to innovation in materials.

It is very critical to match the users' needs and the manufacturers' perceptions to understand problems and to find solutions for these problems. Taking this point into consideration, the new material business division in the center established a membership system. As of the end of March 1986, there is a total of 99 companies including users and manufacturers. As I explained earlier, we plan to provide many opportunities for users and manufacturers to discuss needs freely. This is how the center started.

Suzuki: I looked at the 1985 business report. The center has been very active in giving seminars and lectures.

Hayashi: That is one of the functions. Further, we need an evaluation method and evaluation technology in order to evaluate whether a material is good. Thus, we came to the conclusion that we need testing and inspection divisions.

Suzuki: What is the annual fee for users and manufacturers in the new material division?

Hayashi: Y600,000.

Suzuki: That's about Y6 million for 100 companies.

Hayashi: Yes, that is only from dues. We also receive various grant and test fees. Last year, the center was operated with a total budget of Y400 million, Y100 million for the new material division, and Y300 million for the test and inspection division. The center handles existing and new polymeric materials and polymeric composite materials. The center confirms, evaluates, researches, studies, develops, and improves technology relating to practicability, safety, reliability, and high-performance properties. Furthermore, we strive for progress of related industries, improvement of the environment, and a contribution to the development of civilization.

Future Progress of Space and Aerospace-Related Advance Composite Materials

Suzuki: I would like to have your opinion about the future development of space and aerospace-related composite materials since Mr Hayashi is a specialist in the aerospace-related area.

Hayashi: Advanced polymeric composite material is also included in the advanced composite material. New perceptions and needs are being created. As you correctly pointed out, my speciality is in the aerospace area. I was technology chairman of the National Space Development Agency. I am currently a consultant. Because of this, I have been greatly interested in materials used in space and the aerospace-related fields.

Composite material, especially advanced composite material (ACM), receives a lot of publicity nowadays. Material used in the space and aerospace-related fields should be light-weight and perform well. Countries all over the world have been investing a huge amount of money promoting national research and development.

In Japan, we established the "Fortified Plastic Association" in 1955. About this time, the United States was establishing FRP [filament reinforced plastic] technology, especially GFRP [glass fiber reinforced plastic], in which glass fiber is used. We worked hard in order to catch up with the United States. Due to hard work, we achieved the use of a high-strength fiber such as boron fiber and silicone carbide fiber. Of course there was graphite carbon fiber. Dupont produced "Kevlar." A rapid development of fiber and matrix occurred.

We held the first Composite Material Society meeting in 1955. This year is the 11th year. The first International Conference of Composite Materials (ICCM) was held in Geneva and Boston in 1975. Since then, I have been assisting the international conference as an international committee member. The fifth conference was held in San Diego last year. The fourth was held in Tokyo. Since the founding of ICCM, the conference has been held in many places. It has expanded significantly.

Japan's International Position in Research and Development of Space and Aerospace-Related Composite Material (ACM)

Suzuki: Many countries have been actively developing space and aerospace-related composite material. The United States can actually take material into space for testing. However, it appears that Japan is in an unfavorable position since Japan has to ask the United States to conduct the tests. If so, how unfavorable is it in terms of the research and development of ACM?

Hayashi: Boron fiber was first used on the space shuttle. Composite material for structural use, and boron fiber reinforced aluminum, and boron fiber reinforced epoxy resin, were first used in Space Shuttle No 1. This led to a move for the creation of a space laboratory. In this case, composite material between carbon fiber and epoxy resin or polyimide resin is molded by an automatic molding machine to produce structural material. Research and development of this type in automatic molding machine are very advanced in the United States. There is an American manufacturer which makes any structural material so long as the raw material is provided.

Future material will be composite material having a fine ceramic as its matrix. Japan and the United States are on a par in the research on and development of this material.

Suzuki: When I had an interview with President Itoh of Toray, which is a leading manufacturer of carbon fiber, he mentioned that Toray delivers carbon fiber material to the U.S. market. However, they cannot obtain sufficient information regarding manufacturing conditions. I assume there must be, as a material manufacturer, some difficult aspect to manufacture composite structural material for space as a material manufacturer. What do you think?

Hayashi: Since the U.S. demand is enormous, it seems that the United States is a little ahead of Japan. In Japan, there is no military demand, so the emphasis is placed on the private demand for composite material. Thus, Japan has a wider range of development. I believe Japan's basic study has caught up to the level of the United States.

Recently the U.S. Department of Defense (DOD) put restrictions on the publication of studies on MMC (metal matrix composites) at an international conference. Thus, most of the studies are not reported. For example, in the United States, research on and the development of a reinforced composite material, such as the inclusion of aluminum fiber, carbon fiber, or silicone carbide fiber into aluminum, must be well underway. However, DOD put restrictions on publishing. When the ACM International Conference is held in the United States, those who do not hold American citizenship may not participate in the meeting. There are many international conferences about composite material in various places, but very few American papers are published.

Suzuki: Then how can Japan utilize research and development information about SDI if Japan wants to participate? The newspapers pointed out this problem.

Hayashi: I wonder how SDI will develop. There is a delicate aspect here. Back to the subject of studies about which DOD put restrictions on publication, there is another example. There is a carbon-carbon composite material which is made by putting carbon fiber into resin and burning it while adding pressure. This material is used for a rocket nozzle. It has high heat resistance, plus it is strong and light due to the inclusion of carbon fiber. There are no publications or reports in this critical field either.

Suzuki: You mentioned that those who are not American citizens cannot attend the conference. If someone wants to have information badly enough, there is always a way to obtain information, for example, asking an American citizen to attend the conference and obtain information. It seems nonsensical.

Hayashi: It may be possible. But detailed technical information, for example, the burning temperature and how it is reached, is not disclosed. I advise the Japanese to publish studies as much as possible. While the United States is holding back studies, if Americans know from Japanese publications that Japan is already manufacturing material, I think the Americans will eventually publish their studies, papers, and data, which may not be up to date.

Suzuki: What you are saying is that the Americans may think there is no need to keep their research and studies secret because many papers and much data are already published in Japan.

Hayashi: Yes, that's what we are recommending.

Rapid Development of Multilateral and Bilateral Conferences Regarding Composite Material, and the Role That the Polymeric Materials Center Should Play

Suzuki: Do I understand correctly that Japanese composite-material technology has already reached the level which you described before?

Hayashi: Yes, a product has already been manufactured. It is for a rocket nozzle. A Japanese manufacturer has been manufacturing a rocket nozzle for the National Space Development Agency or the National Laboratory for Space and Science. It's done by the space development section of Nissan Jidosha. The maker claims that it is no secret in Japan.

Suzuki: That is, many Japanese papers were published. Similar U.S. papers were published later on. This gives an impression that the United States is behind Japan. The Americans may not like the idea, thus they may publish many papers.

Hayashi: It may be true. This is why we believe that Japan should take the initiative and publish as many papers as possible.

Suzuki: A country from which the United States would like to withhold information must be Russia.

Hayashi: The Russians may think that Japan is in a position which bridges the United States and Russia. It looks as if the Americans are concerned about this.

I would like to talk about composite material conferences. Because of the belief that Japan should actively cooperate internationally, the first bilateral composite material conference between the United States and Japan was held in Japan in 1981. The second conference was held in the United States in 1984. The third conference was held in Tokyo this June. The number of studies reported have been increasing annually. The number of American as well as Japanese participants also increased.

The first bilateral composite material conference between Russia and Japan was held in Moscow in 1977. The second one was held in Tokyo in 1979. Since then, there have been no conferences held due to the poor international relationship. However, Russia suggested the commencement of the bilateral conference.

Since then, we had the first bilateral conference between China and Japan in 1984 in Shanghai. We are planning to have the second conference in Tokyo this fall. We are urging active cooperation in such bilateral conferences....

Suzuki: We understand that you have frequently been abroad. Is this work the main purpose of your trips?

Hayashi: Yes, that is correct.

Suzuki: It must be that a lot of effort is required in such bilateral conferences, is it not?

Hayashi: Yes.

Suzuki: Is your recent trip to China related to this?

Hayashi: That's correct. The first international composite material conference was held in Peking, China. I cooperated with the organization committee.

Expectation on Japan's Research and Development Activities on Composite Material Judging from International Conferences

Suzuki: At the beginning of this interview, I asked you questions. Would you be able to tell us, from your experience and involvement in many international confrences, in which area Japan is very strong or which area of the advanced composite material requires more emphasis?

Hayashi: Our belief is that in order to improve Japan's level it is very beneficial when our work is evaluated and commented upon. From this belief, we are making the utmost effort to build the foundation of the "Japan Composite Material Society," which was rather small when it started.

It is a good experience and is stimulating for young Japanese to look at things from an international perspective. By the way, young people these days are quite good at English. We, the older ones, are not good. Young people report their studies in excellent English.

We plan to look at the studies in terms of quantity and quality. In terms of quality, the Japanese studies are almost at the international level. Rather, excellent studies are being done.

Those who research composite material in Japan number about 2,000. They are specialists. In the United States, my understanding is that there are about 2,000-3,000 people.

Suzuki: Then there is not much difference between the two in terms of the number of people.

Hayashi: In the United States, a majority of people work for aircraft companies. The ratio of those who are engaged is 1 to 3 between Japan and the United States.

Suzuki: What is the ratio of those 2,000 Japanese who specialize in polymer, ceramics, and metal?

Hayashi: I don't know. It is a difficult question. Maybe there are many in FRP because FRP was very popular at the initial period and still is.

Significant Effects of Innovation of Advanced Composite Material on Automobiles and Airplanes

Suzuki: There would be many people in the polymer field if FRP were active, wouldn't there be?

Hayashi: You could be right. FRP has been a primary material due to the fact that it has good molding characteristics and is light and less expensive. Recently there has been a change. So far plastic has had low heat resistance. However, new plastic, which has a high heat resistance, such as poly-ether-ether-ketone (PEEK) or poly-phenylenesulfide (PPS), started coming out. Thus plastic application is being significantly increased.

It was believed that thermosetting resin and thermoplastic resin cannot be mixed. However, due to IPN (interpenetrating polymer network), a mixture of these is becoming possible. I think this is one example of a composite material.

Suzuki: It is PP composite material, isn't it?

Hayashi: Because of the improvement of heat resistance achieved by innovation, plastic has been used in automobile parts and in the vehicle body itself. I believe an automobile can be made more energy efficient due to material innovation.

Suzuki: I had an interview with Mr Taguchi, chief of the Material Laboratory of Nissan Jidosha. He said that composite material parts are more expensive, but when parts are placed on the assembly line, conventional parts require more labor because of bolt fastening and so forth. On the other hand, one solid piece made by composite material does not require any labor, resulting in a fast assembly speed. When cost is compared at the finish line, the total cost is less when composite material parts are used.

Hayashi: Yes, there is certainly such a benefit. Assembly of an airplane is done by welding. Tens of thousand of parts, depending upon the size, are used for the assembly of a plane. That is, it is a bit-assembly. If these pieces were made of composite material, they could be made into an integral structure. An integral structure can be made without joints. Reduction of the number of parts results in a lighter weight. When the vehicle body becomes light, load on the wheels is decreased as a secondary effect. Thus the weight of the wheels can be less. There has been an increase in a secondary effects like this case.

Suzuki: You used the term bit-assembly. Is this an English word used in Japanese?

Hayashi: Yes, that's right. We use bit-assembly as pronounced. You may call it piece-assembly.

Matrix composite is already used for the engine piston head in Toyota automobiles. Aluminum reinforced with aluminum whiskers can be used in practical application. However, it will not be successful unless productivity increases.

In composite material, molding technology is very critical. Unless molding technology is firm, composite material properties which you expect to have cannot be obtained. For example, unless molding technology is firmly established even with FRP, reliable and high-quality products cannot be produced. Thus, technology is so important.

Evaluation Technology and Evaluation Tests That Determine Speed of Realization of New Material

Suzuki: In order to manufacture many kinds of extremely good material in a large quantity, inspection and evaluation that the center performs is very important....

Hayashi: You are quite right. For ordinary parts, the JIS standard is the base. When new material is produced, it is imperative that an evaluation method, evaluation technology, and evaluation of test methods for new material be developed at the same time.

Suzuki: Recent trade newspapers reported that Nippon Kokan commenced research regarding the discovery of air bubbles based upon FRP's quality evaluation technique. Is it a usual route that manufacturers use the evaluation technique authorized by the center?

Hayashi: We encourage them to utilize our results. We have some available facilities. We are very happy if manufacturers utilize them. We certainly welcome recognition by manufacturers.

Suzuki: From the user's point of view, if manufacturers sell their products with such specifications, users can use them without worry. In that sense, specifications for evaluation technique and others will be needed.

Hayashi: I think so. The quality evaluation of different material requires a different method and technique. Japan has to put much effort in this area.... The United States is far advanced.

Suzuki: We often hear from users that they do not feel at ease using engineering plastic because specifications are not well established, especially precision molding processing....

Hayashi: You are quite correct. That's why we first have to standardize and then have specifications.

Suzuki: Does that mean that the plastic or composite material manufacturers try to meet the standard, or that each manufacturer has its own specifications?

Hayashi: In the United States, each aircraft company has its own specifications, such as Boeing material specifications, called BMS, or Lockheed material specifications. I think in the future they will be consolidated into standards like ASTM (American Society for Testing and Materials) or maybe something like the ISO standard.

Companies in the United States are actively doing the same thing as Nippon Kokan reported in the newspaper.

Suzuki: Is it all right, for example, for a company to show Boeing's BMS to vendors in order to manufacture BMS?

Hayashi: If know-how is not contained in the specifications, I think there will be no problem. However, in most cases, know-how is usually contained, thus it is better to be cautious. There is no problem for know-how already in the ASTM standard.

Suzuki: Does it require a large-scale facility to establish an evaluation technology?

Hayashi: In the material system, evaluation technology, quality evaluation technology, and testing equipment and facilities are required. For example, there is a weathering test center for the weather resistance test. This laboratory is founded with support of MITI in Choshi, Chiba. We work in cooperation with the laboratory.

Is There Any Difference Between Base Material and Material" By-Talk (I)

Suzuki: I asked you questions that I planned to ask. I have a final question concerning terminology. The August supplement "New Sozai (Basic Material) and New Zairyo (Material)" was published. I was also involved in that issue. You also use words "sozai" or new "sozai" as in the "sozai" center or new "sozai" business department. How do you distinguish between "sozai" and "zairyo"? Would you comment on this? Your personal opinion is fine. In English, both are described as material, which does not distinguish between the two, thus it seems to me there is not much difference in nuance.

Hayashi: You are right. We have to be very careful when we think of the true meaning of words. So your question is very important.

Suzuki: Let me put my question in this way. Why didn't you choose "polymeric zairyo center" instead of "polymeric sozai center"?

Hayashi: It seems that the term "new 'sozai'" was used in conjunction with MITI. We sometimes have a difficult time having the name "sozai center." The "so" in "sozai" should not be considered "shabby." We would like to interpret "sozai" as basic material. This is my personal interpretation.

Suzuki: We better emphasize during this interview that the "so" in "sozai" does not mean "shabby" but "basic."

Hayashi: The term "new 'sozai'" has been widely used. When people hear it, they conceptually associate it with new material. Thus, we came to the conclusion to use "sozai." On the other hand "sozai" may give an impression of "shabby" material. As Mr Suzuki suggested, new "zairyo" may be acceptable too.

Suzuki: There was this opinion. I agree with it. The process of turning natural resources into a final product is compared to the flow of a river. "Sozai" is compared to upstream and "zairyo" is compared to downstream. This is how the nuance of the two words is distinguished. I think it is appropriate to distinguish them in this interpretation.

Hayashi: I think that is a good point. That is, "zairyo" is such that the structure of a substance is already determined and made. "Sozai" is "zairyo's" origin.

Suzuki: I guess that we should compromise in that "sozai" is closer to the nature.

Hayashi: It may be convenient to use both meanings. It is so simple if we call it "basic."

Suzuki: When you talk with foreigners while overseas, do you use new materials for "new sozai"?

Hayashi: Yes, I use speciality plastic for functional resin.

Suzuki: The word speciality is often used, isn't it? Since MITI was brought up in this subject, I will give your another example. The word fine ceramics was named by MITI. In Europe and the United States, fine ceramics mean artistic ceramics.

Hayashi: Europeans and Americans do not use the term fine ceramics in the way the Japanese use it.

Suzuki: At an academic society meeting, I insisted that the term will not be understood internationally. The answer was that I may be right but use of the term is already widespread in Japan.... (laughter)

Hayashi: That's true.

Suzuki: MITI creates a new word to use as a tool for securing a budget from the Ministry of Finance.

Hayashi: It is necessary to develop a new area.

Suzuki: Even though the Ministry of Finance may not understand the content, they think MITI plans to work on a new thing that is represented by a new word, so they grant MITI a budget....

Internationally Used Terminology: By-Talk (2)

Hayashi: I mentioned before that I will give you examples later. One example is the term mechanical property, which is used in plastic. Mentors before us translated mechanical property as machine-related property. It sounds strange if the word machine is used in the field of plastics. I said that the translation is not correct. It was my opinion that the word mechanical has another meaning, that is, dynamic, thus the translation should represent this meaning. It was long ago. Now the word is used the way I suggested.

Suzuki: There was not much interchange with foreigners when I was a student. It was probably all right if the Japanese could understand each other. However, in the world in which we live now, we have to use terminology as everyone uses it.

Hayashi: Yes, it is very important. Unless we use the same terminology, we cannot understand each other. The word mechanical was translated as machine-related property. It is incorrect.

Suzuki: I now understand well.

Hayashi: Lanugages are like living things. So they probably change. They have to be accurate as well as in common use. The Japanese translation of SDI is also another example. SDI stands for Strategic Defense Initiative. Thus the correct Japanese translation should have the word initiative in its translation. I wonder why initiative is not included.

Another example is the word re-entry of the space shuttle. This is a description of the shuttle returning into the atmosphere from space. I don't know who translated this but the translation sounds funny. I assume the translation was choosen because the shuttle comes into the atmosphere with such speed.

Suzuki: I see.

Hayashi: So we have to be very careful. As Mr Suzuki pointed out, we have to use the same terminology that all of us, Japanese and foreigners, can understand.

Suzuki: The word which became Japanese is energy. Japanese pronounce the word in German. When Japanese pronounce the term atomic energy, it is a combination of the American and German pronunciations. The Japanese are becoming international, so we have to be careful with words which we use in daily life. During this interview, we talked about terminology. I have learned a lot. Thank you.

Epilogue: At the Completion of Interviews With Top People

I have successfully completed 27 interviews (that was not planned at the outset). According to the editorial staff of this magazine, that number of interviews as well as those who were interviewed could be a Guiness Book record for monthly magazines. Assuming there are 12 pages per interview, there are 324 pages for 27 interviews; assuming there is an average of 1,800 characters per page, this becomes over 580,000 characters. The writer himself is quite surprised.

Fortunately I have been given an opportunity to write up the interviews in the next issue, which will be the conclusion. (By interviewer Akira Suzuki)

(Articles based on these interviews will be edited and published as a separate book.)

13,258/9599
CSO: 4306/3110

HOYA'S ROLE IN 'NEW GLASS' DEVELOPMENT DISCUSSED

Tokyo KOGYO ZAIRYO in Japanese Jul 86 pp 1-14

[Text] 'New Glass' To Go Into Battleline of 'New Material Age'

Akira Suzuki: At a previous interview for this magazine, I heard various stories from former Chairman Iwata of Toshiba, Ltd., about the background of setting up the Japan Fine Ceramics Center (JFCC), and the concept of its future development. As I can now hear a valuable story in detail from you about "new glass" that is deeply connected with fine ceramics, I think I can learn very much about it. For the benefit of the subscribers of KOGYO ZAIRYO I will appreciate it very much if you explain first the difference between ceramics and glass, particularly in what point, and the relationship between the already inaugurated JFCC and the "new glass forum" of which the first general meeting is scheduled for June this year.

Tetsuo Suzuki: Historically speaking, ceramics and glass each have a long history and have followed their path along with the history of man for several thousand years. Ceramics has found its way to the new direction of fine ceramics in the recent new raw material era.

It is certain that we, the glass industrial world, although probably affected by that, also felt the necessity to review glass once again as a new material in the same manner, and have been promoting R&D in that direction for the past few years. I now realize that something fairly promising has gradually appeared, and that this may be the right time to begin to engage in it on a full-scale basis. This is the origin of the new glass forum.

Fine ceramics also is an inorganic material to be sure, but is a material that may be called either crystalline or polycrystalline. New glass is an amorphous material, in which we find the difference in material character. This makes us feel that each will make new developments independently from now on.

The character of glass as an amorphous material has many aspects which are not yet known. But as ceramics is crystalline, its character is known fairly well. I think the direction it will develop in the future is clear. Such being the case, I feel there is a strong possibility that new glass will find itself having a new character. This has probably constituted one of the motives for setting up the forum for us to get together and conduct research.

The new industry will make strides from now on, especially the optical communications industry which has made great strides in recent times. In addition, the biorelated industry is likely to develop. If the electronics industry, for example, continues to develop, new materials will come to be needed at any cost. If I review glass from such an aspect, there is no doubt that something useful for this new industry will appear. Such anticipation and expectations are the motive for the establishment of the forum. I am looking forward to seeing how it will develop in the future.

New Strategy of 'New Glass Forum' Open to World

Akira Suzuki: I understand that you were one of the persons who enthusiastically promoted the establishment of such a forum in 1980 when you became chairman of the Glass Products Industrial Association. The reason you became so enthusiastic is that I imagine you strongly felt there are still many things which are not yet known about glass, while your firm has been engaged in R&D of products at the world's top level, such as "laser glass" or a series of products originating from "mask substrate" for the use of manufacturing integrated circuits. This has probably developed into the enthusiasm to promote setting up the forum just when you became chairman of the Glass Products Industrial Association.

Tetsuo Suzuki: Well, generally speaking, it has been said that the glass industry has matured very much even from the worldwide point of view. There are various kinds of glass such as sheet glass, bottles, glass for tableware, and glass for the use of optical equipment, but I cannot help but think that glass is on the declining trend internationally.

When I became chairman of the Glass Products Industrial Association, I examined very carefully where I should find the future development of the glass industry. If we only continue to manufacture the conventional products, there will be no future and no great development can be expected. One of the factors making development possible is that various kinds of new academic research have been prompted; glass having an unprecedented property has been discovered and new manufacturing methods have been researched step by step in the glass field for the past 20 years or so. Therefore, we consolidated all these things and defined it as "new glass" so we can develop new glass into a new material and make efforts to spread it deeply into the industrial world. By doing so, we came to the conclusion that the glass industry would find a new direction to grow.

We called on the glass products industrial world and set up a "new glass" committee in the Glass Products Industrial Association. I asked researchers in many firms and teachers in universities to get together; we have been holding study meetings for about 5 years. As we did it, the possibility for future development gradually became clear. In order to promote this movement more actively, we asked MITI to lend us a helping hand, and were provided with a cooperative research structure consisting of industry, government, and the academia. As the government has experience in "backing up" the organization of fine ceramics, it helped us willingly, and an organization called the "new glass forum" was inaugurated under the initiative of the government.

Initially, about 70 firms participated, but they increased to 80 recently, and I think they will be about 100 very soon. So, the place for all members to discuss their common problems was set up.

At the same time of setting up the forum, we acquired the consent of the government and paved the way for not only domestic enterprises, but also foreign enterprises to be able to participate. This is based on the idea that it is better to make it an internationally "open" organization, because it begins to deal with the future material as a new organization. Representative special glass makers from Germany, the United States, and the United Kingdom participated. It has become an international organization.

It is absolutely necessary for the enterprises of users of glass products to participate. There will be a limit even though only glass enterprises get together and research the possibility of new glass. An earnest hope for the absolutely necessary participation by users, such as electronics makers and optical communications equipment makers, has been realized, and such an idealistic structure has just been set up. It has now been well developed.

Comparatively promising "themes" have been narrowed down gradually through this forum, and the scale of the market and the forecast of demand have been firmed up gradually also. If this matter becomes clear, we will make a proposal to the government to adopt it as a project based on the "next generation industrial basic technology R&D system" recently promoted by MITI. It may be said that we are now in the midst of seriously thinking about such a thing.

Industry With Proud History Needs To Be Renamed 'New'

Akira Suzuki: I understand that Japanese subsidiaries of Coating Glass Wax of the United States, (Schut) of West Germany, and (Chance Pilkinton) of the United Kingdom participated from the beginning. I think this is a very good posture. I think the rest of the industrial world will follow suit sooner or later.

However, I am wondering if you could easily gain the consent of all members, including the government, as to the participation of foreign capital affiliated firms. I would like to know about it in detail if you do not mind.

Tetsuo Suzuki: All members agreed. There was no attitude on the part of the government either that it is better not to allow foreign enterprises to participate. Neither was there on the part of the firms in the same line of business as ours. They were active, saying that this is a very good thing. The people of the foreign firms were very interested in it also. As there is no such organization in Germany or the United States, it seems that they are very interested in participating in such an organization in which the so-called new glass forum will be set up in Japan, although if the situation permits, I think there could be the case in which something like a research association will come into being in the future. From the viewpoint of new glass research, I feel that the United States and Europe are a little ahead compared with Japan, but it is Japan's unique "system" that such an organization was set up in cooperation among industry, government, and academia. This is almost

inconceivable in the United States and Europe. Over there, the method that private enterprise is doing its way and that universities promote its research independently is prevailing. Therefore, they are very interested in this for the time being.

Akira Suzuki: As it is probably a little embarrassing to ask to participate in such an organization after actual results have begun to grow by means of this unique Japanese system, I think it is a very good thing for them to participate from the beginning. I think you mainly have taken the initiative on this matter.

Tetsuo Suzuki: Recently the government has changed very much for the better. What we worried about most was that if and when this finally becomes a project of the government in the future, the tax of the state will be used more or less for R&D, therefore we entertained some fear as to allowing foreign enterprises to participate. However, the government said there is no problem about that.

Akira Suzuki: As the government has been given a severe blow through trade friction, etc., such a thing may help ease, even a little....

Tetsuo Suzuki: I feel that the government has changed considerably.

By the way, I think functional high polymer as a new material is a very promising material. Fine ceramics is also a promising material in the same manner. In a similar sense, I think new glass is a material with a possibility to become very promising also. The problem is the posture to deal with it. I think the strength in the posture will decide whether or not it will become a very good material.

At present, there are very few researchers in the glass enterprises. There are very few researchers of glass in universities also. The glass enterprises want to increse the number of researchers and make it a great strength. However, in the stock list there are headlines described as "ceramics" and "earth and rock business," which inevitably give an obsolete image to young people. There are few people who want to be researchers in such a field now that other things have come to pass.

Young people want to go to "bio" or "electronics," whatever else might be said. In such an atmosphere, just as "fine ceramics" has been very successful in appealing to students, we, in "new glass," want to make a successful appeal one way or another and, in fact, aim at increasing such researchers as an immediate measure. Unless our industry is such that excellent new young people seek their jobs here, there will be no future development. In this sense, we have a plan to make a strong appeal from now on.

Akira Suzuki: As far as such a point is concerned, when we talked with Chairman Suzuki of Showa Denko K.K. during an interview for this project, as well as Vice President Saeki of Kobe Steel, Ltd., and Vice President Toda of Nippon Steel Corp., they said their main business is each a key industry of the country, but this is recently called an industry of the "heavy-thick-long-and-big" type, resulting in appealing less to young students and thereby

in reducing the number of students applying for positions. They also said with a laugh that although they do not like the expression, unless they do some business of the "light-thin-short-and-small" type to some degree at the same time, young people will not come in large numbers to take an entrance examination.

Tetsuo Suzuki: When I think about it from my point of view, if I were a student now, I would not think that I would be willing to go to such a place. (laughter)

Akira Suzuki: When I think back to my own past days, I realize that people inevitably tend to go to the firm popular at that point of time.

Tetsuo Suzuki: In this sense, I think the reason why the electronics industry developed so rapidly in Japan is based on the degree of interest of the people. Although this has been talked about often in Germany, students of Germany are not fond of electronics very much. Rather, they are interested in the traditional machine and "mechanical" field. This is connected with the fact that we believe Germany is a little behind the United States and Japan in electronics. Based on this example, we are deeply thinking about our intention to make an appeal to students by calling our industry "new glass" and to recruit a large number of new people to this field.

'Top Batter' of 'New Glass' Is Glass Fiber for Optical Communications

Akira Suzuki: At the time of putting the "new" in front of "glass," were there a number of opinions like "advanced" is better, among others?

Tetsuo Suzuki: Yes, there were. I think "high functional glass" is the most accurate expression. Therefore, various expressions like "high performance glass" or "high technology glass" were presented, but the expression of "new glass" was adopted, consolidating those concepts, containing all meanings like high technology and high function, and emphasizing the differences from the "old glass" of the past.

Akira Suzuki: There was a lecture on fine ceramics in the special lecture session of the Chemical Society of Japan (CSJ) in the spring of last year. After the lecture, I got a firm grip on the lecturer with a question. "Fine" is commonly used only in Japan as far as I know. As long as English is used, isn't it necessary to use a word that foreigners will understand? I do not think the word "fine" has been used in various foreign magazines dealing with ceramics.

Tetsuo Suzuki: When foreigners hear the words "fine ceramics" in English in an ordinary situation, what they perceive intuitively is something like beautiful china and porcelain which can be seen in an art gallery. However, when such a word is popularized in Japan, it will be commonly used.

Akira Suzuki: The lecturer said that he did not quite agree with the usage of the word, but he could not help but agree, because dignified key persons

in the Ceramic Society of Japan stubbornly insisted. However, he said in recent times the word has become a little more commonly used overseas also.

Tetsuo Suzuki: That might be true. In the case of "new glass" or "fine ceramics," there was no definition at the beginning, so I think the definition was probably given later. However, there was a change from the traditional "old ceramics" of the past to "fine ceramics," and as for "chemical," there was a change also from the conventional "chemical" to "fine chemical," and in the case of "glass," there is a difference between "classic" glass and "new glass." You see, we might as well say that distinction has been made.

Akira Suzuki: Just like sheet glass, the glass to be produced in large quantities by using the large-size furnace is of the "heavy-thick-long-and-large" type and what is called "new glass" is of the so-called "light-thin-short-and-small" type. Do you think such a feeling is correct?

Tetsuo Suzuki: Yes, I think that is correct, because new glass has a very high added value, but is likely to be extremely small in quantity.

Among the "new glass," optical fiber has exerted the greatest technological impact. There was glass fiber in the past, but optical fiber, compared with glass fiber, has an incomparably high purity in terms of glass material, and the production methods are entirely different from each other. The conventional classic glass, such as sheet glass, bottle glass or tableware glass, is produced by means of melting raw material in the air and cooling it. I will omit a detailed explanation, but silica glass with a very high purity is produced by a method completely different from the manufacture of classic glass. It is manufactured by means of oxidizing the vapor of silicon tetrachloride of high purity by using oxygen gas of high purity.

Fiber finer than human hair is produced from such silica glass of high purity. By putting it into practice, a new technology, such as optical communications, will develop by driving out the communications formula of making electricity flow through a copper wire, which has been practiced so far. In so doing, it is possible to transmit information in several thousand times more volume than that by electric wire by means of making rays of light flow through glass fiber. This has helped the rapid realization of the information-oriented society. Without the realization of optical fiber, I do not think the present communications revolution was possible nor the future communications revolution be made possible.

I think optical fiber is a very good example that its application of various kinds will expand one after another once one innovational material is discovered.

Glass Maker Learns Optical Fiber Materialized by Electric Wire Maker

Akira Suzuki: I talked also with Vice President Nakahara of Sumitomo Denko Co., Ltd., on various matters. At that time, I asked him first, that speaking of glass, although there are so many excellent firms, including the major firms

Asahi Glass Co., Ltd., and Nippon Sheet Glass Co., Ltd., optical fiber was in the end, materialized by an electric wire company. From our viewpoint, I cannot help but feel strange about that, and so I asked him about that situation. He said that he was told, "if a major glass company first materialized optical fiber, we, copper electric wire companies, would be unable to earn our bread. All things considered, the electric wire companies made an all-out effort for fear of being put out of business. At first, we had almost no technological knowledge of and experience with glass, but as we are working hard, we have become more and more conscious and become what we are like now." Certainly when its own lifeline is threatened, an enterprise will become most earnest, don't you think so?

Tetsuo Suzuki: When we were about to begin research of new glass in our association, we said that a glassmaker should have done it from the first. However, glass makers are conservative and adher a little too much to the conventional glass manufacturing method and conventional products. As a result, the business glass makers should have done originally has been done by electric wire makers. As such a thing will never be repeated, I have been constantly stressing for the past 5-6 years that the glass business world has to take the "leadership" and develop new glass.

Akira Suzuki: It was a good lesson, wasn't it? I have friends and seniors in Asahi Glass Co., Ltd., and Nippon Sheet Glass Co., Ltd., and have heard various stories from them over a long period of time. It seems they were feeling as long as they continued to make sheet glass, they would be able to feed themselves and they were working hard for nothing but the R&D of sheet glass. However, while doing so, they were surpassed by Pilkington Co., Ltd., of the United Kingdom in the manufacture of sheet glass in terms of the floating method. There were some people in these firms, however, who are opposed to such a way of doing business.

Tetsuo Suzuki: Traditional industry tends to be of such a kind. And, for another thing, new industry and new technology cannot be caught up with any more as long as the conventional sense by business is maintained. Therefore, although there is a fairly strong force of the glass maker group in the new glass forum, various other firms, such as iron and steel firms, chemical firms, electric wire makers, electronic parts firms, and precision machine firms have also participated. As this is the system in which various kinds of enterprises get together and make efforts to seek the possibilities of new glass, I think that an opinion different from the conventional idea of the people engaged in glass can be expected. In order to create something new for the future, such a system is needed.

Akira Suzuki: I am wondering if there were some makers among those who had been exclusively engaged in glass products for a very long time, who had a fear, were threatened in a certain sense, that "while you lend something unimportant, you will lose something very important" before they became aware of it, if and when various kinds of firms, such as iron and steel and chemical products, participated in such a new system.

Tetsuo Suzuki: That is right indeed.

Akira Suzuki: Conversely speaking, such a sense of crisis will contribute to encouraging them to make efforts in real earnest.

Tetsuo Suzuki: I think it will. In addition, after I talked to the people in such other businesses, I realized they had never met with persons in the glass business. There were many positive opinions that although they do not have enough knowledge about glass, discussing it together will become very useful to them. I think it is true indeed for electric wire companies.

So far, quartz optical fiber system has been practicalized. However, in the next stage, there inevitably will be a limit as long as only quartz is handled, so optical fiber originating from fluoride glass or various new glass will be needed. If so, there will be no boundary between the kinds of business like which is which. In fact, joint research and joint development will come into being. Therefore, optical fiber with performance higher than at present will be materialized. I think probably that it will soon be possible to acquire the technology to transmit rays of light for communications between continents without using a relay.

Optical fiber is an example of a great success in new glass. What is expected to come next is biotechnology-related glass. As one of the biotechnologies in which I am interested, the glass with a very high degree of organism affinity, such as artificial bone or artificial joints and artificial roots, is being materialized. This is also being approached from the side of fine ceramics, but I think this may be next promising area for new glass also.

Akira Suzuki: I had an interview with Managing Director Nakajima of Asahi Glass Co., Ltd. I learned of bioceramics of apatite system and again here.

Laser Glass Development of Hoya in World's 'Top' Position

Tetsuo Suzuki: I think new glass also probably becomes glass of apatite system. However, new glass has more strength than apatite. It is a little difficult to increase the strength of apatite. In the case of new glass, we have what is called crystallized glass. This is an amorphous glass when it is in a melted condition, but will be crystallized when heat processing is applied again. Then it will gain very great strength. In addition, the research for attaining a composite material, while maintaining organism affinity inherent in apatite, whose strength is increased by means of crystallized glass, had advanced to a very favorable stage. Therefore, I think this will be practicalized soon. This is a new use for new glass.

Furthermore, in the new glass fields, I think the field in which optical function will be used is great. What we have to deal with at any cost is laser glass for optical communications, but our purpose is that we like to produce lasers as small as possible in size and as high as possible in performance.

Akira Suzuki: You seem to have made great efforts as a leader until your firm gained a great share in the world in terms of laser glass. I would appreciate it very much if you would tell me about it along with an account of your experiences and so forth.

Tetsuo Suzuki: It has been only 20 years or so since laser was discovered; what appeared first was laser of ruby. Expecting that the same thing as this can probably be done with regard to glass, a U.S. firm, I believe, made public what is called glass laser. We, at the same time, had a very great interest, but....

Akira Suzuki: When was it, perhaps?

Tetsuo Suzuki: It was about 20 years ago. At that time, we did not pay much attention to its practicalization. As you know, our firm has been engaged in optical glass for a long time, so we have been researching the manufacture of laser glass with high performance among laser glasses as a part of our research on optical glass. In the meantime, the United States has begun a project of nuclear fusion reaction. Research to cause nuclear fusion reaction by applying laser to heavy hydrogen has begun. For this purpose, a large-size glass laser is needed at any cost. Therefore, we began R&D by receiving the research expenses from the U.S. Government. Needless to say, U.S. enterprises began R&D at the same time.

Akira Suzuki: Did you engage in R&D in the competitive manner at the same time as the U.S. enterprises did?

Tetsuo Suzuki: Yes, we did. As a result, the performance of our laser glass turned out to be best, and our glass was adopted for all of the world's largest nuclear fusion experiment equipment at the Lawrence Livermore State National Research Institute of the United States. At the same time, Osaka University's Nuclear Fusion Experiment Center of Japan and (Limay) Research Institute of France adopted our glass. Although the equipment of Osaka University is somewhat smaller than that of the United States, it is fairly excellent experiment equipment. We have now reached the stage in which we still try to realize the nuclear fusion reaction equipment by the 21st century.

At present, as it is very large equipment, we are planning to provide laser glass with higher performance, to make a laser oscillator small-size and compact, and to use it for a laser processing machine for consumer use. We strongly intend to do this by ourselves and are now in the midst of developing the oscillator. The conventional laser processing machine uses mostly carbon dioxide lasers and partly YAG lasers, but the carbon dioxide laser necessitates large oscillating equipment, so we are in the midst of making efforts to make it smaller.

Akira Suzuki: What is the point for your victory in the development competition with the U.S. enterprises mentioned earlier?

Tetsuo Suzuki: In short, I think the point is the difference in the optical technology, whatever else might be said. As you know, Japan's camera industry dominates the world. I think one of the major reasons lies in lenses. This means we can make lenses with high performance. We have been consistently engaged in the development of optical glass since the end of the war. We have made efforts in making glass completely homogeneous and high-purified in order to increase the performance of lenses. This has resulted in surpassing the level of ordinary glass. As it were, we are entering the high technology area. What we have acquired by making its level a step higher is laser glass. We increased purity by means of keeping down the impurity mixture allowable amount of ordinary optical glass or lenses by one more digit or less. In addition, the polishing technology to conduct surface finishing much more precisely, and the coating technology to eliminate surface reflection, were developed.

In other words, technology of a level much higher than conventional optical technology is required. We have been engaged in the application of such high technologies.

Akira Suzuki: What is the degree of high purity compared with optical fiber?

Tetsuo Suzuki: it is not as high as optical fiber at the present time. However, sooner or later, almost the same level will be required perhaps.

Akira Suzuki: If so, pure oxygen analysis of silicon tetrachloride as in the case of optical fiber has yet to be conducted. Is that it?

Tetsuo Suzuki: That is correct. At present, we are still in the stage in which melting is conducted in a melting point of platinum. However, it is not effective to conduct melting in ordinary air. Such a fairly "high level" melting as that in a certain atmosphere specially prepared by means of controlling the atmosphere has been conducted.

Akira Suzuki: Is there any prospect that such high purity of the optical fiber level has to be attained sooner or later?

Tetsuo Suzuki: Needless to say, the higher purity we attain, the much higher performance of laser glass we acquire.

Hoya's Series of Mask Products for IC Use Now 'Top' in World's Share

Akira Suzuki: Please give me an account of your experiences in the course of increasing added-value of products of your firm step by step from mask substrate for IC use to mask blanks and photomask, and of expanding the range of products.

Tetsuo Suzuki: There was the time when integration of IC was yet the 4K (kilo) bit. For the mask at that time, ordinary sheet glass was still good. As the integration increased and developed into the 16K bit and the 64K bit, four times and four times again, ordinary glass went out of use, and glass with very low thermal expansion has come to be needed. If the mask substrate made

of glass expands or contracts due to changes in temperature, the printed IC pattern will be distorted. Therefore, we researched and developed nonalkali low thermal expansion glass and produced mask substrate by making application of it. Based on this, it became certain that mask of very high integration and of high performance can be produced. This pleased the IC makers very much. At present, all makers in the world are using Hoya's "LE-30" and efficiently producing the 64K bit dynamic random access memory (DRAM).

Akira Suzuki: Is the composition of the glass included in your patents?

Tetsuo Suzuki: We have the patent, but the manufacturing know-how is a key technique more important than the patent. How to conduct the melting homogeneously is important. A defect of 1 micron or 2 micron or so is not allowed even for the 64K bit. In addition, we want to make the polishing of the substrate surface free of defect. We then attach a thin film of chrome on its surface, but this thin chrome film has to be free of defect also. In conclusion, the glass itself is not allowed to have a defect from the beginning. In the next place, this is needed for polishing flat surface. In addition, this is needed also for thin film on the surface. Such being the case, the technology becomes more and more difficult. Unless such requisite technologies are gathered, photomask cannot be produced. So far, these key techniques have been used for memories up to 64K bit.

Now we deal with the 256K bit and then "mega bit." If so, we know that the low thermal expansion glass will not do at all. Now the quality of the material has changed to quartz (crystal) for the 256K bit and above. This quartz substrate is of synthesized silica glass character and we are now producing substrate for "mega bit" use. The situation becomes more and more difficult, and the technology to respond to it has changed to high technology.

Akira Suzuki: Mask has made growth in such a manner and it follows that beam also has to be X-ray in accordance with that. So, in the end, you have to deal with both.

Tetsuo Suzuki: For the time being, I think electron beam will do probably for memories up to the 4 mega bit.

Akira Suzuki: What will become of it after that?

Tetsuo Suzuki: I think X-ray will appear perhaps. If so, it follows that the present substrate of quartz will not do. As quartz will be impervious to X-ray I think the situation will change in which a completely new mask for use of X-ray has to be produced. If the situation becomes so, new glass will become absolutely necessary.

Therefore, in the case of substrate, we began with what is called ordinary "old glass," but as the application of high performance is required more and more, raw material of new glass in response to that is needed and the new glass has to be of more and more high level. I think promotion of the development in response to such needs and requests from the users' side is also one of the methods. The promotion of providing high function by doing so is, I think, one of the methods for the advancement of new glass also.

Akira Suzuki: In the case of the "LE-30," you responded to the "needs" from the users' side. Is that it?

Tetsuo Suzuki: That is right. However, in the case of the 256K bit, that will not do and quartz ranking one level above replaced it.

Establishment Ahead of Time of Basic Technology Is Necessary for Identity of One's Own Products

Akira Suzuki: I think such needs or requests from the IC makers came not only to your firm, but also to other makers presumably, but your firm sensitively responded to that. Is that it?

Tetsuo Suzuki: You see, there might be a difference in the degree in which efforts are made in such a development. I think other firms also had interest, but it seems that they did not make efforts as much. On the contrary, it might be true that we made efforts several times more than they did. In addition, as mentioned earlier, we have to not only produce raw material, but also polish it very precisely, and yet the work has to be done in the clean room. Furthermore, coating thin film has to be made on it. Unless such requisite technologies are accumulated, a complete mask will not be produced. Therefore, I think there were some makers who stuck somewhere in mid course. For example, they could produce raw material, but could not manage to attach thin film well with their own technologies.

Akira Suzuki: If I look at electronics-related enterprises or other high technology-based enterprises, they are making efforts to prepare necessary requisite technology in a general way in the concept of the so-called basic technology. The concept of basic research has changed to the concept of requisite technology research. Unless you have enough requisite technology, even if you can make such good raw material as you have just mentioned, you cannot complete the final product because you do not have polishing technology. Unless you have basic technology as a system, you will not be able to produce high quality product or it will be impossible for you to make some products which other firms can make.

Tetsuo Suzuki: Therefore, I also think to myself at the time of making an application of new glass that it is not useful just to make public that a new product with such a property has been made as a raw material. If we have completed the raw material with such an interesting property, then we will try to make it a component or a device in some way or another. If possible, by applying the device, we will go further into dealing with system machine. Unless such a development is planned, I think users will be at a loss if only raw material is provided. There are various things for specialists to do, such as polishing raw material of glass very precisely, making very fine fiber, or conducting surface processing. As these things are very troublesome, we have to do these all the way to that extent and produce such "device." And then, we have to make an approach to users to ask for the application of the "device." For this purpose, we must have requisite technologies on hand as you mentioned. Otherwise, we cannot develop raw material into device.

For example, as we talked about laser glass earlier, even if we produce laser glass of high performance, only that does not do any good. It is necessary to develop it into the equipment to oscillate laser by all means. If we can do that, I think it will be possible to make various applications, such as installing it on a processing machine or measuring equipment. Therefore, we will be forced to prepare much more laser oscillators with various kinds of powers. I think we cannot help but enter the stage in which application will begin. Such being the case, I think joint development with users is indispensable in any way for new glass unlike the conventional glass industry.

Akira Suzuki: In this sense, it is a good thing that the new glass forum consists of various kinds of businesses from the beginning, because when something comes up, it will be possible to handle and promote it very smoothly in such a cooperative manner that this portion will be taken care of by this group and that portion by that group. Don't you think so?

Tetsuo Suzuki: I think such is what the system should be. I think it is indeed.

We Call 'Old Glass'--Which Brought About 'New Glass'--'Classic Glass'

Tetsuo Suzuki: If we look at new glass only from the aspect of raw material, it is estimated that the new glass market will become a ¥1.4 trillion market by the year 2000 based on a rough calculation. This is not so "big," but when the raw material is used as an element and incorporated into a system as a device, the business world thinks that the new glass industry will become a ¥5 trillion industry eventually.

The conventional old glass market is a nearly ¥1 trillion market in total, dealing with all kinds of glass products including sheet glass, glass bottles, glass tableware, lightbulbs, braun tubes for TV, cathode ray tubes (CRT) for computers, and glass lenses. The market will become much bigger when we see it from the aspect of raw material. It may be said that the future of new glass is there.

Akira Suzuki: Although I digress from the subject, while I was talking with persons of Nippon Steel Corp., or Kobe Steel, Ltd., I felt they were unwilling to be called the "heavy-thick-long-and-large" type. Therefore, I am wondering how the major glass firms feel if they are called "old glass" as we just mentioned.

Tetsuo Suzuki: They want to be called "classic" instead of "old." (laughter) Glass has a history of nearly 4,000 years. It has a history of 2,000 years since it became transparent glass as it is today. It surely is "classic." In an attempt to renew it in the future, the new glass movement has begun.

Akira Suzuki: Iron and steel makers keep saying that iron and steel will never disappear from the world whatever era comes in the future. This is true with glass, too, isn't it?

Tetsuo Suzuki: Needless to say, it will not disappear. The problem is whether or not it will continue to grow in the future. It is inevitable that the economy will grow. We will then come to ask ourselves if it is all right that only we do not grow. If we realize that we have to grow, too, in accordance with the growth of the economy, I think it is inevitable that we have to promote high technology. There is no worry that glass will disappear, that iron and steel will disappear, and that cement will disappear, but it is not a good thing that an industry will not grow, but just stand still.

It Was a Long Way To Set Up Identity and Specialty of Hoya

Akira Suzuki: Finally, I think you had a hard time as president for a very long time building up basic technology enough to produce laser glass, a series of products for masks, or other high technology products in your firm. Please tell me your philosophy which sustained the hard time.

Tetsuo Suzuki: It was by mere chance that what is called the origin or the inauguration of business of my firm began at producing optical glass.

Akira Suzuki: According to an information brochure on your firm, "HOYA," presented to me a little while ago, it has been 25 years since the name of your firm changed to Hoya Corp. in 1960. What was the name before?

Tetsuo Suzuki: Before that time, it was Hoya Crystal Glass Co., Ltd., after the war. During the war, we were called Toyo Glass Co., Ltd. Our firm was inaugurated in 1941.

Akira Suzuki: According to WHO'S WHO IN JAPAN you entered the firm in 1944.

Tetsuo Suzuki: Yes. it was just before the end of the war.

Akira Susuzki: You then entered Toyo Kogaku Glass Co., Ltd. Is that correct?

Tetsuo Suzuki: That is correct. As it was during the war, Toyo Kogaku had been manufacturing optical glass for military use to be used for optical weapons.

Akira Suzuki: Was it for the Army or the Navy?

Tetsuo Suzuki: We were working for the Navy. The optical weapons were such as the bomb sight and the machine gun sight for Navy aircraft.

Akira Suzuki: I was graduated from university in the spring of 1939, and immediately entered the subdepot of the Navy Air Corp Technical Depot. I was assigned to the ordnance department. There were the optical department, the bomb department, etc., in the subdepot.

Tetsuo Suzuki: In this respect, the development of optical glass was a high technology if it is mentioned in the present fashion judging from the technological level of Japan at that time. This is because no nation but Germany

was able to develop optical glass as you know it. As the war became furious, material was delivered from Germany by using submarine. We were not allowed to be insecure at all to such a degree and we were asked to begin domestic production.

Such being the case, Toyo Optical Glass began with optical glass, so technological development was the life of our firm as a matter of fact. We had come to have such a philosophy.

We worked hard and produced optical glass, and the war ended when we finally successfully produced products of the so-so level. When the war ended the demand from the military discontinued, so the plant had "stopped" its operation until we received the demand from the private camera makers a little later. I think it was probably in 1950 that the domestic production of cameras, Nikon or Canon, began in Japan. Then, Japan's technological level of cameras increased greatly. Optical glass contributed to it.

We became unable to earn a living for a while after the war, so we began to produce "cut glass" called "crystal glass" by applying the technology of optical glass. Thanks to this, we had been able to make a living. This had developed into our present Crystal Business Division.

In this sense, generally speaking, the starting point of our technology is optical glass. Crystal glass was developed from it, and then we became capable of producing lenses for glasses, contact lenses, and frames based on optical technology, and also substrate to be used for IC by applying optical technology.

Although we have been engaged in diversified management, the technology forming one of the bases is optical technology. So is glass manufacturing technology. Lens polishing technology and surface processing technology are the same. I think we can say that the accumulation of these optical technologies is the technology of Hoya. In this sense, our firm looks like a very strange firm if it is seen from other glass makers.

Akira Suzuki: If so, your firm has been keeping on with a very high technological level from the beginning and has not been producing something rough and ready very much.

Tetsuo Suzuki: That is right. Therefore, for example, the real beauty of crystal glass is cut glass whatever else might be said. We polish the surface beautifully and create a prism on the surface. Cut glass glitters when it receives light. Crystal glass has to be transparent to the last. This means that impurity must not be contained. Needless to say, this is almost the same thing as the performance required by a lens. In this sense, crystal manufacturing technology is a high technology.

Our firm has been conducting differentiation of business. While we keep going ahead on such a line for a long time that other firms think Hoya is a strange firm, the sales for only the glass portion of the glass products have become less than a third of the entire sales. As a result, the name of our firm has

moved in the stock market from the ceramics/earth and rock section to the precision equipment section.

Although something new of various kinds on new glass, too, will be discovered from now on, when we see it as raw material, I do not think there will be anything for which new glass will be used in large quantities any more.

Akira Suzuki: How about the "heavy-thick-long-and-large" type?

Tetsuo Suzuki: I do not think there will be any more. In the postwar glass industry, what has become very "big" are braun tubes for TV sets and displays for personal computers. These have expanded very much. And as the development of new glass advances, this will develop into a flat display to a higher degree sooner or later, namely something "compact" and small in volume. That is the place where the requirement of new glass exists. Therefore, I think there will be a great hope and dream on new glass in the future. So, I would like to ask for your favors toward us in the future as well as the present.

Akira Suzuki: I thank you very much for the various kinds of valuable stories you have given me on new glass. I am sure the article of this interview ill meet the expectations of all our subscribers.

20,113/9365
CSO: 4306/3625

STATE-OWNED PATENTS SPREADING ABROAD

Tokyo KOGYO GIJUTSU in Japanese Mar 86 pp 44-48

[Article by Mitsuo Suzuki, director of the Japan Industrial Technology Association]

[Text] Why International Technology Cooperation Is Now Important

With a turnabout from the first oil crisis, the focus of world technology development trend has been shifting toward lightness, thinness, shortness, and smallness [micro] from heaviest, thickest, longest, and biggest [macro]. Countries in the world are fiercely competing for the development of high technologies, amid the great surge of new technologies from the 1970's toward a peak in the early 2000's.

Emerging as advanced technologies are the technology for utilizing limited sources of energy on earth, electronics technology for fostering an information society, new materials technology for bringing about metamorphic progress in industries, and biotechnology with diverse potential.

The collapsing condition of the Japanese economy after World War II has achieved a marvelous recovery through the support of technical assistance from abroad and the concerted efforts of the people. As a result, Japan has now established a high technology level worldwide.

While Japan has currently achieved economic growth through active industrial activities based on high technologies, other countries have increasingly been seeking Japan's technical cooperation. Public opinion is taking root in that Japan should further promote contributions intellectual to the international society through technologies.

As regards technologies under such international circumstances, the recent activities concerning technology transfer and popularization of the Japan Industrial Technology Association (Inc.) (JITA) engaged in activities of spreading state-owned patents of the Agency of Industrial Science and Technology (AIST) at home and abroad will be outlined (see Figure 1)

Transfer of state-owned patents

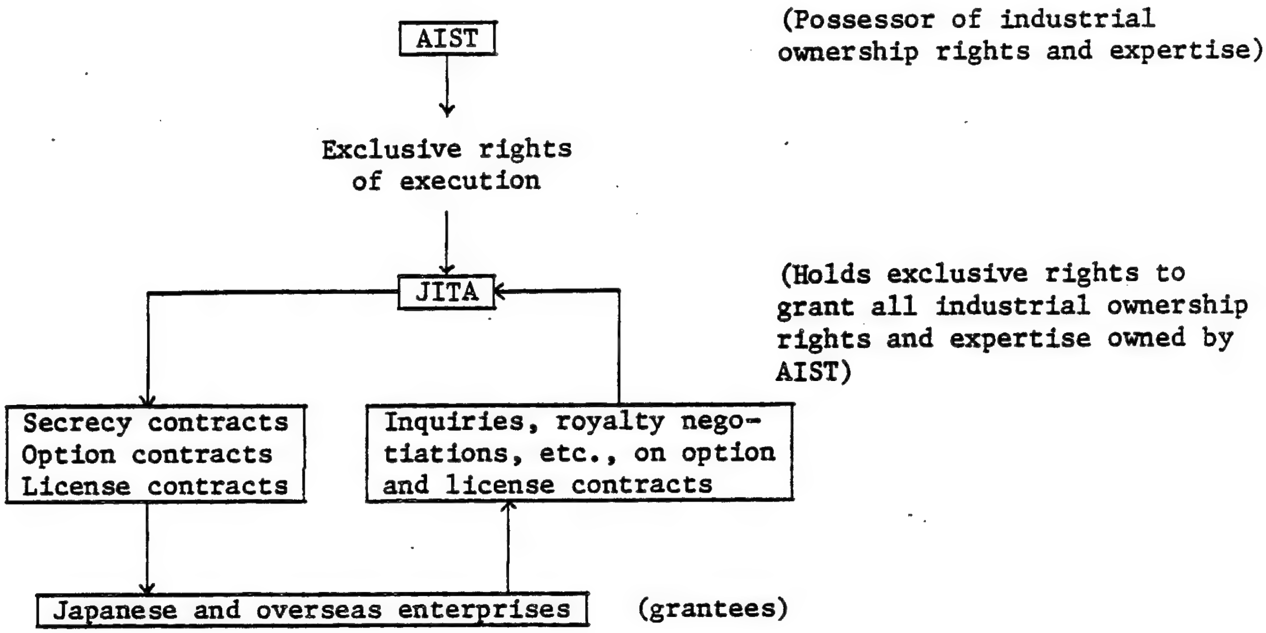


Figure 1. Technical Transfer System of AIST's State-Owned Patents

Activities of High Technology Interchange Missions

JITA has been sending missions to the various European and American countries annually since 1983 to introduce AIST's state-owned technologies in support of AIST and other quarters concerned. The dispatch of the missions is part of the technology interchange between Japan and the various European and American countries, and is also in response to criticism that Japan is not providing technology exports in comparision with the enthusiasm for exports of manufactured products. Among AIST's state-owned patents, 20 to 30 themes, which have been applied for industrial use by Japanese companies or those prospective technologies are selected annually for overseas supply upon approval for technical cooperation by the companies involved.

Missions comprising top technicians or leaders concerned in charge of technical development at such companies visited governmental organizations or research institutes of major enterprises in the various European and American countries to ascertain the needs of such countries (possibilities such as technology transfer and joint development). From this side, technical presentation was provided and at the same time relative discussions pursued.

Institutions visited by year follow:

1983	Sweden	(state) STU (Swedish Technology Development Agency) (private) ASEA Co., Volvo Co.
	West Germany	(private) Dynamite Nobel Co., Siemens Co.
	France	(state) CESTA (Advanced Technology System Development Center) (private) Toulouse City Chamber of Commerce and Industry
1984	United States	(state) Raleigh, North Carolina--Research Triangle Park (research consortium) (private) SWRI, IITRI, SRI (all nonprofit think tanks)
	Canada	(provincial) Montreal Urban Community (research consortium)
1985	Sweden	(private) IDEON (research consortium) (private) SKAPA (creative technology exhibit)
	Ireland	(state) IDA (Irish National Research and Development Agency)
	Britain	(state) BTG (British Technology Group, formerly NRDC) (private) Berkeley Tech Mart '85
	France	(state) CESTA (private) Rhone Poulenc Co.
	West Germany	(private) Bayer Co.

Fortunately, the dispatch of the missions over the past 3 years has resulted in steadily spreading state-owned technologies abroad due partly to the active cooperation of domestic licensee companies and various foreign governmental organizations and overseas companies. Among the themes presented, some concrete results are beginning to emerge, such as supplying information and samples, to include possibilities for future technology transfer and joint development, and the conclusion of secrecy contracts.

Table 1 shows typical technologies presented by the past three missions. A few examples among overseas responses to the missions were the request from Martin Marietta, a major U.S. enterprise, for a supply of several tens of kilograms of high-performance electromagnetic wave shield materials on a sample basis. Kuraray Co. and two other companies are now conducting experiments for practical application of the materials under the guidance of AIST's Industrial Products Research Institute. General Motors Corp. (GM), a major U.S. automaker, Alcan Canada Co. of Canada, Hinkley and ICI of Great Britain, and many other companies have shown interest in revolutionary fine ceramics processing technologies, and negotiations for a contract are now underway with a certain company. The ceramic technologies involved are the ceramics-metal

Table 1. Technologies Introduced Abroad Through State-Owned Patents

Category	Title of technology	Institute that made discovery	Year introduced		
New materials	High-performance electromagnetic shield material	Industrial Products Research Institute	1983	1984	
	Ceramics-metal bonding	Osaka National Industrial Research Testing Institute (NIRTI)		1984	1985
	Ceramics-ceramics bonding	Nagoya NIRTI	1983		1985
	Zirconia sinter	" "		1984	
	Easy-to-sinter alumina	Osaka NIRTI	1983	1984	
	Lubricating agent for die-casting, forging	Daikoshi NIRTI	1983		
	Lanthanum-chromate for heating	Kyushu NIRTI		1984	
	Carbon-ceramics compound	" "	1983	1984	1985
	High-performance pitch carbon fiber	Research Institute for Polymers and Textiles		1984	
	Ultrahigh-molecular polyethylene gel yarn	"		1984	
	Hydraulic injection plastic molding	National Chemical Laboratory for Industry, Kyushu NIRTI, Osaka NIRTI	1983	1984	1985
	High-flux precision filtration membrane and its system	Research Institute of Polymers and Textiles	1983	1984	
	Photocrosslinkage polymer and screen printing	National Chemical Laboratory for Industry			1985
	Gas separation using polyimide hollow fiber	Research Institute of Polymers and Textiles	1983	1984	1985
	Ion exchange fiber and rare earth metal separation	National Chemical Laboratory for Industry	1983		
	High-performance deodorant				
Biotechnology	Production of oils and fats by mycosis	National Chemical Laboratory for Industry	1983		
	Production of gamma linolenic acid by mycosis	"		1984	1985
	Production of heat-resisting lipase and dissolution of oils and fats	Fermentation Research Institute		1984	1985
	High-performance cellulase	"		1984	
	Solidification of oxygen by ultrafine fiber carrier	Research Institute of Polymers and Textiles			1985
	Solidification of oxygen by photocrosslinkable polymer	"			1985
	Production of fry feed from alcohol fermentation wastes	Fermentation Research Institute			1985
	Artificial joints	Mechanical Engineering Laboratory			1985
Electronics	High-performance amorphous silicon solar battery	Electrotechnical Laboratory		1984	1985
	Semiconductor magnetic sensor and its applications	"		1984	1985
	Assessment of amorphous silicon manufacturing process under CARS system	"			1985
	ICTS system for detecting crystal defects	"			1985
	Nonvolatile semiconductor memory with floating gate	"			1985
	High-output GGG laser	"			1985
	Optical disk pickup (SCOOP)	"			1985
	Magnetic garnet film for optical IC	"	1983		

bonding and ceramics-ceramics bonding where research for practical applications is being conducted by Sumitomo Cement Co. and Daihen Corp., respectively, under the guidance of AIST's Osaka Industrial Research Institute. Negotiations are also underway with (Reuter) Gas Werke Co., a major West German pitch processing company, concerning technology to manufacture high-performance carbon fiber now being developed for practical application by more than 10 companies, including Nippon Carbon Co. Regarding lubricating agents for forging and die-casting, Hanano Shoji (Inc.) has completed development of manufacturing technology, and is now being made practical with a large amount of samples being supplied abroad for testing, while Great Britain's (Fuoseco) is seeking technology transfer.

In addition not only enterprises, but also Britain's BTG (R&D agency) and France's CESTA (advanced technology center) are requesting long-term, deliberative cooperative relationships with JITA missions, and are showing an active stance toward future technology interchange with Japan.

Progress in R&D of those technologies have been conducted by research institutions under AIST's umbrella with the cooperation of private-sector companies. Behind-the-scene movements concerning technology transfer through various channels have also been observed, and attention focuses on future developments.

Technological Transfer Based on Trusting Relationship

"The more information is assimilated, the more its essence is improved," is a wise statement about data bases by Tokyo University Professor Hiroshi Inose, last year's Cultural Merit awardee. In technology transfer, too, a certain preparatory period is initially required for the exchange of technologies and related information and establishment of a relationship of mutual trust between the provider and the receiver of technologies. The first problem in negotiating transfer of state-owned technologies abroad is that it takes considerable time to establish such relations of trust. Perseverance is required as in an extreme case where the party completely lacking information mutually about the other party begins from scratch. In addition, based on relations of trust, the supplier and receiver of technologies must seek terms on conditions which will mutually benefit both sides from a long-term point of view. Under such circumstances, recent trends for the future technologies or in exploring new areas such as cross-licensing and other forms are increasing.

Next is the establishment of relations of trust regarding protection of patents. The state-owned technologies to be definitely transferred abroad at present are basically on condition that the technologies involved are patented in the recipient countries. Accordingly, it is important that such technologies are fully protected under the recipient countries' patent system and in the operation thereof.

In the various countries visited by JITA's advanced technology exchange missions in the past 3 years, hardly a problem occurred due to the high reliability of the patent protection measures. However, of late, Japan has been strongly urged to expand technology transfer to the newly industrialized countries (NICS) and developing nations. The problem of patent protection in those countries will therefore be an issue to be resolved in the future.

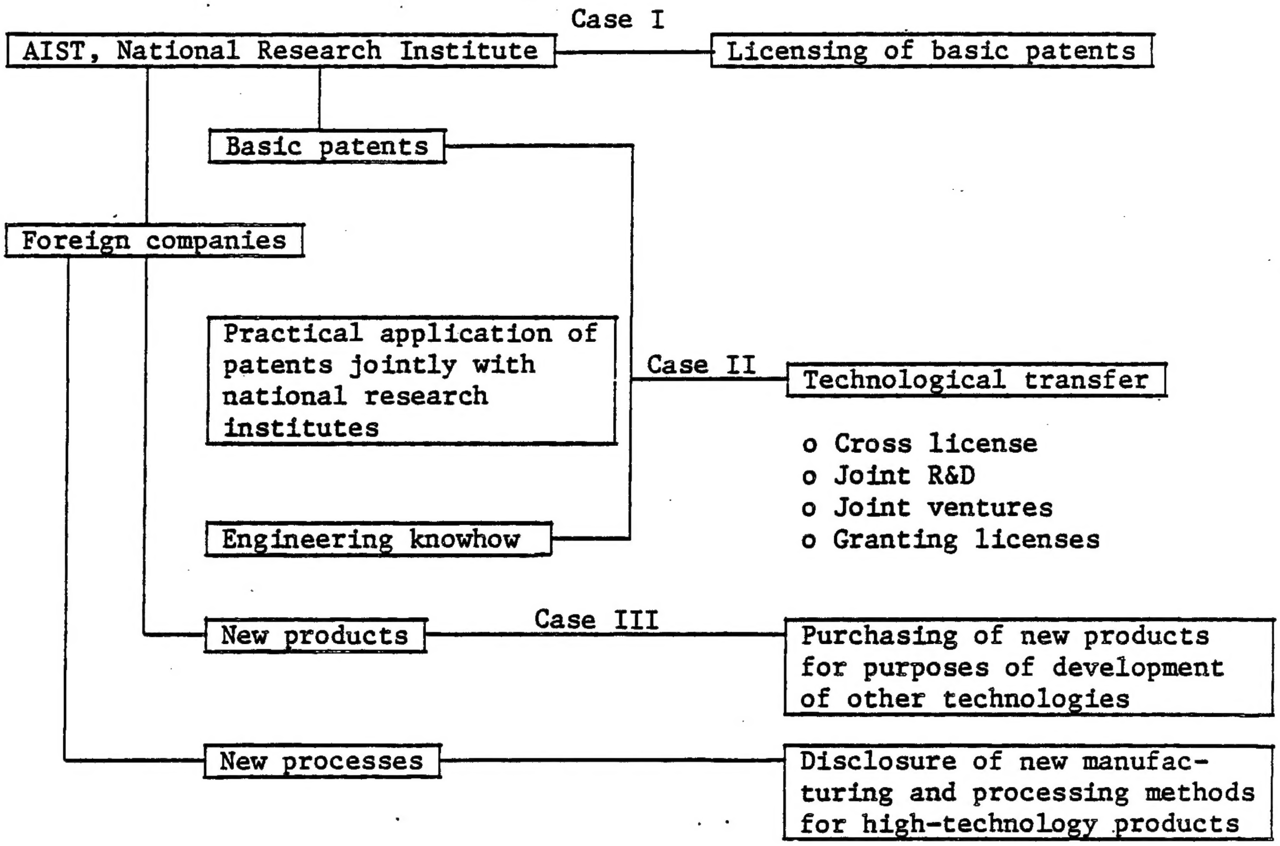


Figure 2. Technology Transfer of State-Owned Patents Abroad

Four Cases of Technological Transfer and Procedures for Transfer

Transfer of state-owned patents has various backgrounds depending on the technologies involved, which is not easy to generalize into one format. However, it can be classified roughly into four cases as shown in Figure 2.

Case I is the licensing of basic patents owned by the Agency of Industrial Science and Technology and of patents jointly owned by the national research institutes and private companies. Case II involves providing all the information necessary for commercialization ranging from basic patents owned by the AIST to related patents, manufacturing know-how and product specifications, etc., possessed by the implementing companies--in other words, the complete transfer of technologies. Depending on circumstances for the suppliers and the receivers of technologies, Case II can be subdivided into four types, i.e., cross-licensing mutually between companies, joint development by both companies for furtherance of technologies involved, establishment of joint ventures between companies based on mutual agreement and conditions for local production and sales, and the unilateral supply of all the technologies to the other country's enterprise in exchange for payment of certain remunerations.

In Case III foreign companies purchase products of technologies involved from the contract-implementing firms of Japan and use such items as a basis to develop new processes or new products. In Case IV foreign companies produce and process products on a contractual production basis, using high technologies developed from basic patents owned by the AIST. For example, one plan now under negotiation is the contractual production of special parts by a foreign enterprise using the "ceramics-metal bonding technology."

Table 2. Procedures for Technology Transfer

First stage Secrecy agreement	Providing secret information and samples necessary for assessment of technologies involved
Second stage Option agreement	Technical information including know-how, etc., data regarding economical phase, and samples or marketable products necessary for feasibility study
Third stage License agreement	All information necessary for practical application of technologies

Procedures for granting licensing of state-owned patents abroad are basically identical to those in Japan. The first stage, as shown in Table 2, is to cope with clients when they seek more detailed information and samples to be furnished so as to determine the industrial value concerning the nature of the technologies. In such case, if necessary, a secrecy agreement is concluded before providing them.

The second stage is for coping with cases where further concrete information beyond the first stage is sought by the clients such as information about economical feasibility, information concerning marketing and technical information to determine the industrial applicability of the technologies, as well as providing samples on a commercial basis, etc. Usually in this stage, information is furnished under an option agreement on the assumption that technologies involved will be applied for industrial purposes.

The third stage is the execution of technology transfer under a license agreement in which the contract discloses all technical information necessary for the application of technologies and the nature of the patents.

For the Future

Japan is a small country in terms of natural resources, energy, and food, but is substantially rich in intellectual resources. Using these resources, the country has accumulated industrial property and other technology assets since the end of the last war, making itself one of the leading technology-oriented countries in the world. Such intellectual assets will continue to serve as a bargaining power for Japan.

However, today's accumulation of technology assets has resulted from the introduction of technologies from advanced countries in Europe and America, and efforts for creative technology development. Moreover, in the background of facilitating Japan's introduction of technologies from European and American countries is the sense of trust when Japan was furnished technologies, being accustomed to assessing fair value of new, superior technologies which furthered the understanding of patent protection.

Meanwhile, Japan has been strongly criticized by various countries in Europe and America for its huge trade surplus stemming from expanding exports of manufactured products. Of course, free world prosperity lies in orderly exports and imports under the free trading system. However, Japan's export of its abundant intellectual resources, resulting in a surplus in the technology trade balance, would not create trade friction, but would rather contribute to the development and revitalization of the world economy. The conditions to smoothly transfer technologies overseas are as stated above. The three issues of relations of trust, mutual benefit, and patent protection have been proposed. However, these problems in the case of NIC's and developing nations are such that environments are yet to be sufficiently regulated. It is extremely important that Japan mutually cooperate in resolving these problems for future international cooperation.

20129/9365
CSO: 4306/3613

END